

# Food Selectivity and Nutritional Conduct in Children with ASD: An Integrative Review

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Received: 28 Dec 2021,

Received in revised form: 12 Feb 2022,

Accepted: 20 Feb 2022,

Available online: 28 Feb 2022

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**keywords**— Autism, eating behavior, feeding,  
children, food selectivity

**Abstract**—Autism Spectrum Disorder (ASD) is a condition characterized by difficulty in social interaction, in addition to affecting the development of language and communication. Food selectivity is one of the outstanding characteristics in this group, generating significant nutritional deficiencies in children and adolescents with ASD. The objective of this integrative review was to verify, through the available literature, aspects related to the eating behavior and health of children with Autism Spectrum Disorder. Developed in was developed in six steps: 1. elaboration of the research question, 2. definition of the sources of selection of primary studies and the inclusion and exclusion criteria, 3. definition and extraction of data, 4. evaluation of the included studies, 5 • critical analysis of the results, 6. presentation of the synthesis of the evidence found. According to the results presented, about eating problems, it was evidenced that children with Autism Spectrum Disorder are more prone to the development of food selectivity and micronutrient deficiency than children with typical development. In addition to requiring greater involvement and frequency of their parents/caregivers concerning their peers during meals. As is evident the presence of risky eating practices within this group, occurring more frequently among children with ASD than among neurotypical children. Thus, it is suggested the production of more studies on the subject and the development of public policies that cover this group.

## I. INTRODUCTION

Autism Spectrum Disorder (ASD) is a condition characterized by difficulty in social interaction, in addition to affecting the development of language and communication. Other characteristics are also present in the Disorder, such as restricted, repetitive, and stereotyped behavior patterns in addition to sensory changes and eating problems, being selectivity feeding one of the major causes in the development of nutritional deficiencies and obesity in people with ASD [1].

As mentioned, food selectivity is one of the main existing behavioral changes and is related to a sensory disorder and hypersensitivity to touch that can directly compromise food acceptance consequently, they may have difficulties in processing some information such as texture, pigmentation, flavors, format, temperature, type of packaging, among others [2].

Children with ASD are much more selective and resistant to the introduction of new foods, which makes them more likely to develop eating difficulties that can

lead to nutrient deficiencies, compared to typically developing children. The percentage of autistic children who present food selectivity is perceived on average from 40% to 80% in children with this disorder [3].

Overweight and obesity frequent in children with ASD have been attributed to the repetitive and restricted eating behavior of these children. Due to inadequate diet and lack of energy balance that can directly influence food consumption, thus contributing to overweight [4].

Therefore, the objective of this integrative review is to verify, through the available literature, aspects related to the eating behavior and health of children with Autism Spectrum Disorder.

## II. METHODOLOGY

### 2.2 Type of study

This is an integrative literature review that was developed in six stages: 1. elaboration of the research question, 2. definition of the sources of selection of primary studies and the inclusion and exclusion criteria, 3. definition and extraction of data, 4. evaluation of the included studies, 5. critical analysis of the results, 6. presentation of the synthesis of the evidence found [5].

To prepare the research question, the Population - Interest - Context (PICO) strategy was used, in which P - children with Autism Spectrum Disorder (ASD), I - food selectivity, and eating behavior were considered. Thus, the guiding question was: What aspects are related to the eating behavior and health of children with ASD?

#### 2.2.1 Scenario

The search for primary studies was carried out at the Biblioteca Virtual en Salud (BVS)/BIREME. Using the following descriptors in English: nutrition, autism, and eating behavior. Access to the database took place in December 2021 through the researchers' remote access.

#### 2.2.2 Inclusion criteria

As a method of selecting the articles to compose the review sample, the following inclusion criteria were adopted: primary studies that present topics related to the food selectivity of children with ASD, nutritional management in patients with ASD, nutritional status of children with food selectivity, available in Portuguese and English, and published from January 2017 to December 2021. As exclusion criteria, the following were adopted: dissertations, thesis, and case report.

#### 2.2.3 Data collection

To search the databases, controlled descriptors (terms structured hierarchically, used in the indexing in the databases) of the Medical Subject Headings (MeSH) and Descriptors in Health Sciences (DeCS) were used. The

descriptors were cited in the search of the BIREME database with the AND connector and at the same time, during one week. The search strategy was conducted to contemplate the peculiarities of the database and time restriction filters (last 5 years) were added.

#### 2.2.4 Data analysis

The search for studies, sorting and data extraction were performed by three researchers, who standardized the search strategy in the database and performed it independently, with subsequent comparison of the results found.

The analysis and integration of results were based on the method of data reduction, which consisted of critical reading. And for the theoretical support of the critical analysis of the results, the scientific literature on the subject was used, and these studies were not included in the review. The presentation of results descriptively took place, aiming to promote the incorporation of evidence and the identification of gaps in knowledge.

Table. 1: Database search strategy

Base de dados	Search strategy
BIREME	nutrition, autism, and eating behavior

The review variables were categorized in a spreadsheet using the Microsoft Excel 2010 program, containing the following information available in the primary studies: year, country, type of study, objectives, method, and conclusion.

#### 2.2.5 Ethical aspects

The protocol of this study will not be submitted to the Research Ethics Committee, since public access studies available in the scientific literature will be used.

## III. RESULTS

During the manual search in the database, 39 articles were identified. All were selected to read the abstracts. Remaining 16 studies are for a full reading. Of these, 15 studies were linked to Pubmed/MEDLINE and 1 to LILACS. After applying the selection criteria, all 16 studies were included to integrate the research. The main reason for exclusion from the studies was the escape from the theme.

With 93.75% of these linked to Pubmed/Medline. Regarding language, 15 articles were published in English and 1 in Portuguese. Regarding the countries where the research was conducted, 31.25% of the studies were

carried out in the USA, 12.5% in Spain, 12.5% in Turkey, and the other countries collaborated with 6.25% of the studies each (Brazil, Poland, China, Australia, South Korea, Malaysia, and India).

Regarding the type of study, 37.5% were cross-sectional and observational studies, 12.5% were case-control studies, 12.5% were exploratory and descriptive studies, 12.5% were systematic reviews, 6.25% were observational

and case studies. -control, 6.25% retrospective review, 6.25% cross-sectional study.

Most of the studies analyzed (95%) reported a high prevalence of food selectivity among children with ASD, as well as a low intake of proteins, fruits, vegetables, and vegetables by them compared to children with typical development. 50% of the studies analyzed described unhealthy eating habits and some micronutrient deficiency among children with ASD. In addition, there are data among the studies that point to a relationship between this food selectivity and the development of malnutrition and other comorbidities.

Among the studies (25%) it was also possible to perceive the role of parents/caregivers during the feeding time of children with Autism Spectrum Disorder (ASD),

and the use of negotiation and reward methods for children to ingest certain foods, and there is a usually greater insistence that the child eats during meals.

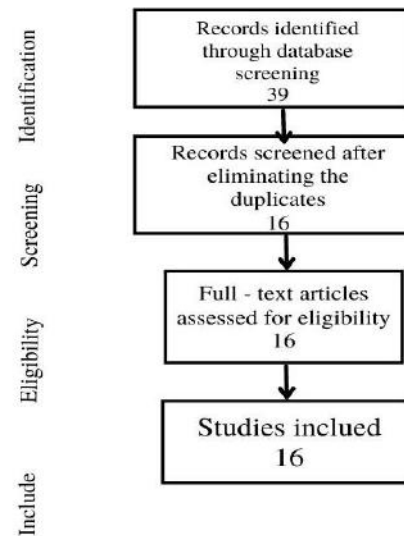


Fig.1: Flowchart of the integrative review articles selection process.

Table. 2 present the types of studies, methodology, objectives, results, and conclusion of the primary studies.

Table.2: Synthesis of the articles selected for the integrative review.

TYPE OF STUDY	TITLE	AIM	METHODOLOGY	RESULTS	CONCLUSION
Cross-sectional and observational study	Feasibility of virtual nutrition intervention for adolescents with an autism spectrum disorder [6]	This study aimed to examine the feasibility of a virtual implementation of Bringing Adolescent Learners with Autism Nutrition and Culinary Education, an 8-week nutritional intervention based on the social cognitive theory that addresses eating	The implementation process was measured with loyalty checklists, engagement logs, and field notes. The feasibility of virtually evaluating adolescent outcomes (food frequency questionnaire, psychosocial survey, height, and weight) was also evaluated. Adolescents with autism spectrum disorder aged 12-21 years were recruited through a local community partner.	Six groups (n = 27; group size ranged from 2 to 7) participated. Univariate data analyzes were performed. Mean class attendance was 88%, participation was 3.5/4 (4 = Often), completion of homework was 51.9%, fidelity was 98.9%, and the prevalence of	Data quality was high for 88% of food frequency questionnaires and 100% of psychosocial surveys. The results suggest that a virtual implementation and assessment of adolescent students with autism through nutrition and culinary education was feasible. It can be implemented virtually to reach diverse

		behaviors on the autism spectrum and dietary challenges.		technical difficulty was 0.4 / 2 (2 = Major technical difficulties). The assessment completion rate was 100% (98.9% – 100%) at baseline and 92.6% – 96.3% (99.5% – 100%) post-intervention.	populations of adolescents with an autism spectrum disorder.
An observational and case-control study	Dietary Patterns, Eating Behavior, and Nutrient Intakes of Spanish Preschool Children with Autism Spectrum Disorders [7].	The present study aimed to determine the PDs and macro and micronutrient intake in a sample of Spanish preschool children with ASD compared with typically developing control children.	Fifty-four children with ASD (two to six years of age) diagnosed with ASD according to Diagnostic Manual criteria-5) and a control group of 57 typically developing children of similar ages were recruited. A validated food frequency questionnaire was used, and energy and nutrient intakes were estimated using three non-consecutive 24-hour dietary records. PDs were evaluated using principal component analysis and hierarchical cluster analysis	Children with ASD exhibited a PD characterized by high intakes of energy and fat and a low intake of vegetables and fruits. Likewise, consumption of any type of meat, both lean and fatty, was associated with higher consumption of fish and dietary fats. In addition, increased consumption of dairy products was associated with increased consumption of cereals and pasta. In addition, they often consumed industrialized	In conclusion, this study emphasizes the need to assess the PDs and nutrient intake of children with ASD to correct their alterations and rule out some potential nutritional diseases.

				products of low nutritional quality, such as beverages, sweets, snacks, and bakery products. The percentages of children with ASD who meet the adequacy of nutrient intake were higher for energy, saturated fat, calcium, and vitamin C, and lower for iron, iodine, and B vitamins when compared with control children.	
Retrospectivereview	Intensive multidisciplinary feeding intervention for patients with avoidant/restrictive food intake disorder associated with severe food selectivity: An electronic health record review [8].	The purpose of this study was to examine the clinical presentation, intervention characteristics, and treatment outcomes for young children who received IMI for restrictive food disorder (ARFID) involving nutritional insufficiencies associated with severe food selectivity.	The statement on Strengthening the Report of Observational Studies in Epidemiology was followed to conduct this retrospective chart review. The review focused on consecutive patients (birth to 21 years) admitted to the IMI program over 5 years (June 2014 to June 2019). Inclusion criteria called for micronutrient insufficiencies (vitamins A, B12, C, D, E; folic acid; calcium; iron; and zinc) and chronic mealtime refusing behavior (e.g., turning the head	During the 5 years, 63 of the patients met the study entry requirements. Of these, 60 patients (50 boys and 10 girls; mean age = $72 \pm 39$ months; range = 23–181) completed the intervention (95% treatment completion rate). At discharge, dietary diversity improved in 16 new therapeutic foods (range: 8–22), rapid	The results of the current study support the benefits of IMI for increasing food variety, improving mealtime behaviors, and increasing nutritional intake in children with ARFID who have severe food selectivity.

			away from food) / spoon, push or throw the spoon, cry, scream and leave the table) associated with severe food selectivity.	acceptance and swallowing of new foods exceeded clinical standards (80% or > bites), and the risk of nutritional inadequacies decreased for this cohort of patients.	
Cross-sectional study	Parental Reports on Early Autism Behaviors in Their Children with Fragile X Syndrome as a Function of Infant Feeding [9].	This study aimed to evaluate the prevalence of autistic behaviors in fragile X syndrome as a function of children's diet.	We analyzed retrospective research data from the Fragile X Syndrome Nutrition Study, which included data on infant feeding and caregiver-reported developmental milestones for 190 children with Fragile X syndrome enrolled in the Fragile X Online Registry With Accessible Database (FORWARD).	Sex-specific exploratory associations were found linking soy-based infant formula use with worse autistic language-related behaviors in women and self-injurious behavior in men. These findings lead to a prospective assessment of the effects of soy-based infant formula on disease comorbidities in fragile X syndrome, a rare disorder for which newborn screening could be implemented if there were an intervention.	Gastrointestinal problems were the most common reason for switching to soy-based infant formula. Thus, these findings also support the study of early gastrointestinal problems in fragile X syndrome, which may underlie the development and severity of disease comorbidities. In conjunction with comorbidity data from previous analyses of the Fragile X Syndrome Nutrition Study, the results indicate that mothers with premutation fragile X children should be encouraged to breastfeed.



Case-control study	Eating Behaviors of Children with Autism-Pilot Study [10].	This study aimed to assess the nutrition of children with autism, with particular emphasis on feeding in the first year of life, compared to the healthy peer group.	Participants included 75 white children (41 children diagnosed with pure autism and the control group consisting of 34 children without autistic traits). The analysis was carried out based on a self-designed questionnaire, the first part being dedicated to early childhood feeding practices.	Results: $p = 0.04$ ), late introduction of dairy products ( $p = 0.001$ ), need for more trials to introduce new foods ( $p = 0.006$ ), late introduction of foods with a solid and granular structure ( $p = 0.004$ ), longer bottle feeding time ( $p = 0.005$ ); delay in trying to eat with one's own hands ( $p=0.006$ ) and need for greater support from parents to divert attention from eating during feeding ( $p=0.05$ )	It was concluded that: 1. Eating problems are more common among children with autism spectrum disorder than among the population of healthy children during the first year of life after the introduction of complementary foods. 2. Autistic children have difficulty eating and require additional parental involvement much more often than their healthy peers.
Cross-sectional and observational study	An investigation of the relationship between the eating behaviours of children with typical development and autism spectrum disorders and parent attitudes during mealtime eating behaviours and parent attitudes during mealtime [11].	The present study aimed to determine the PDs and macro and micronutrient intake in a sample of Spanish preschool children with ASD compared to a control group of typically developing children of the same age.	A total of 180 parents of children aged between 3 and 5 years in Ankara participated in the study; 90 were parents of children with TD and 90 were parents of children with ASD. The variables were measured using the Brief Assessment of Mealtime Behavior in Children (BAMBI), the Child Eating Behavior Questionnaire (CEBQ), and the	The results revealed that food refusal, disruptive behaviors, and limited variety in children with TD were related to parental actions, such as the use of rewards. We also found a negative correlation between the enjoyment of food and the use of	Despite the differences, the eating behaviors of children with TD and ASD show similarities in some cases. If a child has little interest in eating, parents tend to be pushier, use more rewards, and offer special meals. On the contrary, the child's great interest in eating impairs the parents' behavior. As the

			Parent Meal Action Scale (PMAS).	rewards. Children with ASD showed differences in food refusal, and their parents prepared more special meals for them compared to children with TD.	recognition that there is a relationship between children's eating behaviors and parental actions could make it easier for intervention to shape attitudes through parents, it is recommended that future studies be carried out to respond to children's eating problems, working together with your caregivers.
Case-control study	Eating Behaviors and Diet Quality in Chinese Preschoolers with and without Autism Spectrum Disorder: A Case-Control Study [12].	To compare mealtime behaviors and diet quality in Chinese preschoolers with autism spectrum disorder (ASD) and typically developing preschoolers in Hong Kong.	This study included a community sample of 65 families with preschool children with ASD aged 3-6 years and 65 families with preschool children with typical development matched for age and sex. The eating behavior of preschoolers was assessed using the Brief Autism Mealtime Behavior Inventory and the Preschoolers' Eating Behavior Questionnaire (CPEBQ). Preschoolers' usual diet and nutrient intake were assessed using a validated food frequency questionnaire. Diet quality and diversity	Compared with the typically developing group, the ASD group had higher scores in the food refusal domain of the Brief Mealtime Behavior Inventory ( $P<0.001$ ), the CPEBQ food agitation domains ( $P=0.001$ ), and eating habits ( $P=0.001$ ). $P=0.001$ , and lower CPEBQ exogenous feeding score ( $P=0.003$ ) and initiative feeding score ( $P<0.001$ ).	Preschool-aged children with ASD showed more feeding and mealtime problems, and lower diet quality and diversity than their typically developing counterparts. Our results highlight the need for regular monitoring and early identification of behavioral and nutritional problems during meals among preschool children with ASD.



			were generated using the Chinese Children's Food Index total score and the diet variety score. Differences between groups on various scales and dietary variables were examined using linear regression or multivariate logistic models adjusting for baseline demographic differences.	The Chinese children's total Food Index score ( $P = 0.001$ ) and diet variety score ( $P = 0.005$ ) and intake of soy and soy products ( $P = 0.001$ ) were lower in the ASD group compared with the typical development group.	
Cross-sectional and observational study	The nutritional behavior of children with autism spectrum disorder, parental feeding styles, and anthropometric measurements [13].	The objective was to evaluate the nutritional behavior, anthropometric measures, and feeding styles of caregivers of children with ASD.	104 children with ASD and 100 controls were included in the study. The children's weight and height were measured and recorded by the researchers. The Infant Feeding Behavior Questionnaire, the Parental Feeding Style Questionnaire, the Developmental Assessment Form, and the Sociodemographic Data Form were administered by their caregivers.	Children with ASD were difficult to feed as infants, experienced more problems transitioning to complementary feeding, were more selective about food, and were fed diets with a more limited variety than the control group. The BMI z-scores for children with ASD were higher than those for children without ASD, while their height z-scores were lower. Children with ASD exhibited more	Children with ASD are more selective about foods and have a harder time switching to complementary foods. The BMI-z score for children with ASD is higher and the z-height score is lower. Children with ASD have different eating and eating styles compared to children in the control group.

				<p>responsiveness to food, emotionally overeating, appreciating food, cravings for drinks, undereating, and food-selective behaviors, whereas parents of these children used more emotional eating, instrumental eating, and tolerance-controlled eating styles than the parents of the controls.</p>	
An exploratory and descriptive study	<p>Young Adults with High Autistic-Like Traits Displayed Lower Food Variety and Diet Quality in Childhood [14].</p>	<p>This study aimed to explore the association between autistic-like traits in young adults and early childhood food intake in the Gen2 Raine Study cohort.</p>	<p>Data were collected from available information from 811 participants at 1, 2, and 3 years of age for the assessment of dietary intake, and at 20 years of age for the measurement of autistic-like traits.</p>	<p>Results showed that as autistic-like traits increased, total food variety, staple food variety, and dairy variety decreased (<math>p &lt; 0.05</math>), with lower consumption of citrus fruits and yogurt (<math>p &lt; 0.05</math>). both <math>p = 0.04</math>). As autistic-like traits increased, diet quality decreased, this trend was significant at 2 years (<math>p = 0.024</math>).</p>	<p>From the results, it is suggested that young adults with higher autistic-like traits were more likely to have lower food variety and quality in early childhood.</p>

Cross-sectional and observational study	Increased emotional eating behaviors in children with autism: Sex differences and links with dietary variety [15].	This study aimed to examine emotion-related overeating and undereating based on parental assessments of these behaviors in children aged 4 to 17 years with autism spectrum disorder compared to typically developing children of the same age.	A total of 190 children aged 4 to 17 years with Autism Spectrum Disorder were selected and 119 typically developing children of the same age were selected, and the assessment was made from the point of view of the parents or caregivers of these children.	Children with autism spectrum disorder were rated as exhibiting more emotional eating behaviors and more eating than their normally developing peers. Furthermore, although sex differences in these emotional eating behaviors were not seen in typically developing children, girls with autism spectrum disorder were rated as having more emotional eating behaviors than boys with an autism spectrum disorder.	It is concluded that among all children with autism spectrum disorder, excess emotional eating was related to increased consumption of sweet foods and decreased consumption of vegetables. These findings have implications for a better understanding of eating habits in children with autism spectrum disorder and suggest that emotional eating behaviors can have immediate and later health impacts.
Systematicreview	Nutritional Deficiency Disease Secondary to ARFID Symptoms Associated with Autism and the Broad Autism Phenotype: A Qualitative Systematic Review of Case Reports and Case	The primary objective of this review was to examine the relationship between the demographics, weight status, dietary patterns, and nutrient deficiency illnesses that characterize the most severe	A systematic review of articles in English and non-English published until August 29, 2019, in the electronic databases Scopus, PubMed, and Cumulative Index to Nursing and Allied Health Literature Plus was performed. Additional cases were identified	A total of 76 cases (patients aged 2.5 to 17 years) from 63 articles published from 1993 to 2019 were found. More than 85% of the cases (65 of 76 patients) were articles published in	Based on the 63 articles extracted for this systematic review, nutritional deficiency diseases related to inadequate intake of vitamin A, thiamine, vitamin B-12, vitamin C, and vitamin D were

	Series [16].	manifestations of avoidant/restrictive eating disorder symptomatology associated with autism or the broad phenotype of autism. autism.	through the reference list of all included articles. The search terms used were "autism * AND (deficiency OR scurvy)". Only case reports or case series were included in which a person of any age who was identified as having a formal diagnosis of autism or symptoms of autism and a nutritional deficiency disease due to self-imposed dietary restrictions were included. Data were independently extracted by 8 authors using predefined data fields.	the last 10 years. The highest percentage of published cases (69.7% [53 of 76]) involved scurvy, a vitamin C deficiency. The second-highest percentage of published cases (17.1% [13 of 76]) involved eye disorders secondary to the deficiency of vitamin A. Other primary nutrient deficiencies reported were thiamine, vitamin B-12, and vitamin D. In 62.9% (22 of 35) of patients who were given a body mass index or weight percentile for age, the patient was within normal weight parameters, per the Center for Disease Control weight status categories.	found in individuals with autism and broad autism phenotype who had severe autism. - dietary restrictions imposed. When weight information was provided, most youths in these cases were not reported to be underweight. Individuals of any weight who exhibit symptoms of avoidant/restrictive eating disorder may benefit from early and frequent screening for adequacy of micronutrient intake, regardless of whether they have a clinical diagnosis of autism.
Exploratory/Descriptive/Qualitative study	Food and nutritional aspects of children and adolescents with	Understand the eating habits, difficulties, and strategies of children and	The study is characterized by presenting a qualitative approach of the exploratory	The data collected in the work were separated into 3 thematic	Adolescents and children with ASD have difficulties in sensory

	an autism spectrum disorder [17].	adolescents with autism spectrum disorder (ASD).	and descriptive type, it was conducted with the help of a semi-structured interview with 14 parents of children with ASD who study in a specialized education school, the research was carried out from April to May 2019 in a city in southern Brazil.	categories: eating habits of children and adolescents with ASD; eating difficulties of children and adolescents with ASD; and dietary strategies for children and adolescents with ASD. It was identified from the parents' reports that only 8.8% of children and adolescents had healthy eating habits, 1.6% of them had good eating behavior, while 16.8% of children and adolescents had unhealthy eating habits. healthy high consumption of ultra-processed foods. The second category identified 9.6% with reported binge eating, the main behaviors of food rejection identified by parents were food refusal	activities, making healthy eating habits difficult, in addition to having a high consumption of ultra-processed foods, eating difficulties with low acceptance of foods with solid consistency, and, therefore, they tend to have unhealthy eating habits.
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				(14.4%) and decreased acceptability for solid foods (13.4%), among the most common symptoms caused by difficulty in eating, 15.9% were found to have disorders in the Gastrointestinal Tract (SGI), followed by lactose intolerance (4.8%) and emesis (3.8%). In the third category, there were low percentages about the dietary strategies made with children and adolescents with ASD.	
Cross-sectional and observational study	Mealtime Behaviors and Food Preferences of Students with Autism Spectrum Disorder [18].	Identify mealtime behaviors and age-based food preferences in students with ASD to prevent problematic eating behaviors and promote healthy nutrition for proper development.	The study was conducted using an online questionnaire that aims to identify mealtime behavior and food preferences. Participants were 130 parents of students with ASD who were studying at a school in Seoul, South Korea from January 30 to February 17, 2020.	The average age of the students was $14.1 \pm 6.1$ , the analysis of problematic behavior during meals was divided into levels, cluster 1 of low level, cluster 2 of medium level, and cluster 3 of high level. According to the WHO BMI criteria, 30.8% were	The study is characterized by presenting a qualitative approach of the exploratory and descriptive type, it was conducted with the help of a semi-structured interview with 14 parents of children with ASD study in a specialized education school, the research was carried out in April to May



				underweight, 40.8% were normal, 15.4% were overweight and pre-obese, and 13.1% were obese. The data collected showed that cluster 3 had a high level of problematic behavior, 66% were younger than 10 years old and had a low food preference.	2019 in a city in southern Brazil.
Qualitative/Transversal type research	Exploring Eating and Nutritional Challenges for Children with Autism Spectrum Disorder: Parents and Special Educators Perceptions [19].	Explore nutritional knowledge among parents and special educators of children with ASD and how this is reflected in their food provision practice through a qualitative approach	The study is characterized by being cross-sectional and qualitative, where semi-structured focal discussions (FGDs) were carried out with 20 participants who were parents and educators of children with ASD at the National Autism Center in Malaysia to identify understanding about a healthy diet.	The inductive analysis linking the codes to the main categories was made from comparisons of the collected data. The study indicated little knowledge about healthy eating and especially about adequate nutritional needs for children with ASD.	The study identified little information from parents and educators related to the health of children with ASD regarding adequate food and nutrition, therefore, an educational tool was suggested to assist parents and educators in implementing a healthy lifestyle for children with ASD
Systematic review	Differences in food consumption and nutritional intake between children with autism spectrum disorders and typically developing	To determine the general differences in nutritional intake and food consumption between children with autism spectrum	The study is a Systematic Review performed on the PubMed/Medline databases and the Cochrane Library databases by the MOOSE guideline for systematic reviews and meta-	19 studies were included in the study, in which there was low protein intake (standardized mean difference = -0.27, 95%	The study showed that children with ASD had lower intakes of foods rich in protein, calcium, phosphorus, selenium, vitamin D,

	children: A meta-analysis [20].	disorder and control (typically developing) children, as well as to determine the extent to which the nutritional intake and food consumption of autistic children meet dietary recommendations.	analyses of observational studies and the PRISMA Guideline for preferred reporting.	confidence interval (−0.45, −0.08)), calcium (−0.56 (−0.95, −0.16)), phosphorus (−0.23 (−0.41, −0.04)), selenium (−0.29 (−0.44, −0.13)), vitamin D (−0.34 (−0.57, −0.11)), thiamine (−0.17 (−0.29, −0.05)), riboflavin (−0.25 (−0.45, −0.05)) and vitamin B12 (−0.52 (−0.95, −0.09)) plus polyunsaturated fatty acid (0.27 (0.11, 0.44)) and vitamin E (0.28 (0.03, 0.54)) than the controls. They had lower intakes of foods rich in omega-3 (−0.83 (−1.53, −0.16)) and higher intakes of fruits (0.35 (0.12, 0.59)) and vegetables (0.35 (0.09, 0.61)) compared to children in the control group.	thiamine, riboflavin, and vitamin B12 and higher intakes of PUFA, vitamin E, and fruit and vegetables compared to the control group. According to the recommendation of the DRI, children with ASD may be at risk of deficient intake of calcium, vitamin D, and dairy products, but it is understood that the results are based on a limited number of studies, requiring studies with larger samples.
Prevalence/Cross-sectional/Observational study	Dietary patterns and anthropometric	This study aimed to focus mainly on diet	Food intake and behavior problems during meals were	The study showed that 85% are male	The work was characterized by being a pilot

	measures of Indian children with an autism Spectrum disorder [21].	patterns and their impact on children's somatic status with ASD.	analyzed in 53 children with ASD aged 2 to 13 years, characterized by a pilot, cross-sectional and observational study carried out at the All India Institute of Speech and Hearing (AllSH), which is located in India from January to April 2016, with the help of 3-day Food Records, Child Behavior Inventory and Food Frequency Questionnaire.	and 15% are female, according to the Indiana Scale for Autism Assessment (ISAA) of the 53 children with ASD, 28.3% are mild, 62.2% moderate, and 9.4% severe. The highest percentage according to the age group is children between 2-4 years old (37%), in short, the age group ranged from 2 to 13 years old. Boys aged 2 to 5 years had higher percentages of overweight (13%) while most boys aged 6 to 13 years (15%) were underweight while most girls had adequate weight in both age groups. According to food intake, it was observed that there was lower consumption of fruits and vegetables, thus indicating smaller	study and identified little food variety to the low consumption of fruits and vegetables by children, in addition to overweight and low weight rates, which suggest future studies. The psychosocial difficulties about the acceptance of parents make it difficult to seek early specialized and multidisciplinary care. It is emphasized that micronutrient deficiency issues can have several negative repercussions for health, in addition to healthy eating being a factor of great importance for multidisciplinary work and for improving the health of children with ASD.
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				amounts of B vitamins, minerals, especially calcium and iron in the diet of children with ASD. It was suggested the need to implement programs related to nutrition and feeding of children with ASD in the Mysuru region, India.	
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#### IV. DISCUSSION

##### 4.1 Nutritional Status

According to ŞENGÜZEL et al. [22] children with ASD had a higher percentage of obesity in relation to the population of children who were not on the spectrum. TOSCANO et al. [23], based on a longitudinal approach conducted in Brazilian children and adolescents with ASD, showed growth retardation in children between 8 and 9 years of age, at the beginning of the puberty phase, and BMI below the recommended, affecting, therefore, pubertal growth. The problem was mainly due to food selectivity; in addition, there was a high rate of overweight in early childhood, especially due to the absence of physical exercise and the psychomotor difficulties of children with ASD.

TKACHUK, MARTYNOVICH, and GLOBENKO [24] state that other factors have a great influence on BMI and body adiposity, especially gastrointestinal disorders, as diseases of the Gastrointestinal Tract (GIT) are common in this population and alter the microbiota, immune response, and functionality of the Gastrointestinal System (SGI). Psychotropic medication prescribed to treat behavioral aspects, as well as sleep disorders, may be related to the inadequacy of the nutritional status of children with ASD [23].

Severe food selectivity does not only affect the intake of macronutrients in the diet but also, according to SHARP et al., (2018), represents a high-risk factor for nutritional inadequacies related to micronutrients,

especially in the levels of vitamin D, vitamin E, and calcium in addition to the low consumption of dietary fiber. In the studies by TKACHUK, MARTYNOVICH, and GLOBENKO [24], nutritional deficiencies of minerals such as potassium, calcium, and lithium increased the incidence of neuropsychiatric symptoms in children with ASD, in addition to altering endocrine and metabolic aspects and delaying the evolution of physical and mental development. in these individuals. Therefore, programs aimed at tracking and monitoring the nutritional deficiencies of children and adolescents with ASD are of great importance to prevent the negative effects triggered by these nutritional deficiencies.

##### 4.2 Eating Habits

According to studies on behavior and food selectivity by SHARP et al. [25], caregivers of children with ASD indicated that they have low consumption of vegetables and fruits. According to studies by ŞENGÜZEL et al. [22], which aimed to examine factors related to eating disorders and the incidence of obesity in children with ASD, indicated higher percentages of food refusal among children aged 2 and 5 years, which influenced decreased consumption, especially in the fruit group. , vegetables, yogurts, eggs, and cereals, in addition, children had a high consumption of milk, and foods rich in carbohydrates. The selectivity and food refusal of children and adolescents with ASD, especially the low acceptance of foods with solid consistency, and the decrease or rejection of the consumption of natural foods together with the increase in the intake of foods with high concentrations of simple carbohydrates and saturated fats represent risk

eating habits for the development of NCDs, especially obesity.

#### 4.3 Behavior and Food Selectivity

Food selectivity in children with ASD is described in the literature as one of the causes for greater food restriction, which can lead to micronutrient deficiencies and/or the development of Chronic Noncommunicable Diseases, especially obesity [20].

And according to one of the articles analyzed in this review, Plaza-Diaz et al. [26], in a study on eating patterns of children within the Autism Disorder Spectrum, realized that children with ASD had a PD (Eating pattern) characterized by relatively high consumption of cereals, pasta and dairy products and a small intake of lean meat and eggs compared to the SENC (Spanish Society of Community Nutrition) guidelines, and all children, both in the control and TEA groups, consume few fruits, vegetables, and fish. And about the group of children with ASD, there is a large intake of fatty meat and its derivatives, in addition to drinks, snacks, sweets, confectionery, and pureed foods compared to children in the control group. Such behavior is encouraged throughout the lives of children with ASD, since as they grow, they restrict food more, worrying their parents/caregivers and leading them to use these foods as a means of reward for eating certain healthier foods, or in more severe cases of selectivity, being the only food that the child tolerates.

However, the recommendation for the introduction of food is to offer foods with different textures, adjusted to the child's developmental skills about feeding, such as sucking, swallowing, biting, chewing, as well as small motor skills. At first, the texture should be smooth, then lumpy. In the 9th month, food should be, and the soft parts of food should be placed in the child's hands. From the 12th month of life, at least, the child should eat at the family table, which means that no more restrictions on the textures of the products given to the child should be maintained, regardless of whether it is a child with ASD or with typical development, however, research indicates that the introduction of solid foods for children within the Autism Spectrum is carried out later than generally recommended [10]. Data that may explain the high selectivity for this group throughout life, as well as aspects related to olfactory sensitivity, could also be linked to the development of this characteristic.

#### 4.4 Nutritional Conduct

Children's eating behaviors are shaped throughout the developmental period, starting from the prenatal period. Genetic predispositions, the family environment, and their eating behaviors, educational institutions, as well

as the mass media affect children's eating patterns. Thus, children within the Autism Spectrum would be no different, but their high food selectivity requires special attention from professionals to avoid possible nutritional deficiencies [27](DE COSMI; SCAGLIONI; AGOSTINI, 2017).

According to CASSEY et al. [28] in their observational and descriptive study among students diagnosed with ASD and students with typical development in a school, the use of a "Good Behavior Game", seeking to promote the consumption of fruits and vegetables, showed encouraging results, since students developed autonomy in choosing more nutritious foods through the approach. Although according to the authors, the method needs to be implemented in larger groups, the method demonstrated that the use of integrative and playful practices could be promising ways to reduce food selectivity not only in children with ASD.

As a treatment of food selectivity, the conduct that has shown the most positive results in the clinical environment is Sensory Integration Therapy, the approach acts in the creation of appropriate stimuli for children with ASD, where these sensory experiences should help in the development of adaptive responses to the means, for a process of adequate interpretation, concerning the senses: touch, smell, taste, hearing, and vision. For a harmonious development and functioning of the central and peripheral nervous system, including motor skills and agility, visual and auditory perception are the bases for the development of communication skills, that is, dysfunction at any of these levels will result in psychological deficits sensory and motor, including speech and communication deficits [29]. In our study, it was possible to perceive the high prevalence of food selectivity among children with ASD, as well as measures that can help to improve this behavior were presented, as described by BURO et al. [6] in their observational and analytical study with adolescents with ASD, the results suggested that a virtual implementation of Culinary Education can be used to reach different populations of adolescents with Autism Spectrum Disorder, presenting satisfactory results, and improves the diet of this public, as it promotes interaction with food and increased acceptability.

Based on the analysis by BRZÓSKA et al. [10] the introduction of complementary foods into the diet of infants is significantly more difficult in children with ASD. It has been described that children with autism, as well as children without developmental deficits, mostly ate with the family, this fact led to challenging eating difficulties for parents and other family members, significantly increasing the level of stress as well as decreasing the self-

assessment of parental competence. The feeding process requires multiple attempts and special involvement from parents/caregivers in the form of playing with the child or redirecting the child's attention from food to devices such as TVs, computers, or tablets to facilitate feeding and happens most often with children with ASD than with healthy children.

The findings described above corroborate the data in the literature on the subject, confirming the importance of working together between health professionals and parents/caregivers to reduce food selectivity among children with ASD.

## V. CONCLUSION

Regarding eating problems, it was evidenced through the analysis of this review that children with autism spectrum disorder are more prone to the development of food selectivity and micronutrient deficiency than children with typical development. In addition to requiring greater involvement and frequency of their parents/caregivers in relation to their peers during meals. As is evident the presence of risky eating practices within this group, occurring more frequently among children with ASD than among neurotypical children. Thus, it is suggested the need for early identification of nutritional inadequacies in children with ASD, and the development of more studies to evaluate food consumption, selectivity, and micronutrient intake, therefore, there is a need to create obesity programs for children and adolescents. adolescents with ASD, and Food and Nutrition Education Programs aimed at educators and caregivers of children with ASD, aimed at improving the health and quality of life of these individuals, improving their physical and mental development, and reducing the risk of developing Chronic Diseases.

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